

The Connection of Chemistry and Medicine

*ADDRESS AT THE OPENING OF THE MEDICAL CLASSES,
TUESDAY, OCTOBER 21st, 1890*

BY

JOHN FERGUSON, M.A., LL.D., F.S.A.

REGIUS PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF GLASGOW



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AT THE OPENING OF THE MEDICAL CLASSES,
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IN the regular succession of the years it has come round once more to me, at the opening of the Session, to address the customary welcome to you. I do so most cordially on behalf of my colleagues in the Medical Faculty, and the Senate as a whole. It is the desire of every one here that you should profit to the full by all the advantages which an ancient and famous University affords, and at the same time that you should do so with the greatest amount of enjoyment. There is, perhaps, a prevalent feeling that a University is a place where learning is presented to the student as an infliction rather than as an attraction, and it may be that some of you have come with the intention of doing as little as possible, and of impressing your teachers with the idea that what they have to

demonstrate is not of sufficient value to induce you to take any trouble to acquire it. If there be any such I would venture to advise them to withdraw as soon as they can, and to seek some calling more congenial to their mental bias than any of those that can be learned here. I do not say this with the motive either of exalting the pursuits of this place, or of depreciating the capacity of those who find these pursuits not to their liking. On the contrary, there are other avocations quite as worthy of their energies in which they may achieve as much distinction as in any of the so-called learned professions. Not that they will escape the necessity of having to think or to take trouble, whatever may be the calling they follow, but it will be labour for what is agreeable to them, not a wearisome task which they have to constrain themselves to perform, and which, after all, will be imperfectly because half-heartedly done.

It is worth while, however, for the student to remember, that the commencement of every new branch of knowledge is surrounded with difficulties more or less trying, more or less repellent, and that these must be overcome somehow before he can say whether the topic interests him or not. All this requires effort, which if he elect not to make, he had better relinquish the work

altogether. In consequence of these preliminary obstacles of the student it has been the aim of some of my predecessors to attempt to give advice how and what to study. The advice so given has been excellent, the result of long experience and dealing with students. I have not, however, myself observed that general advice tendered to such an audience as the present has much effect. Each one approved of it, doubtless, for everybody except himself; but each one had also settled for himself a scheme of work to be successful in or not; anyhow, better suited to his particular circumstances than the plan which the speaker advocated. The adviser, I fancy, is apt to forget how different are the capacities, the tastes, the training, the stage of advancement, the aims of those whom he addresses, and may not see how a method suitable for some might never meet the case of others at all. With what I cannot help regarding as a futile attempt before me, I am reluctant to trouble you with recommendations about study that would not be adopted, and might not be successful with you if they were.

When I turn to the subject with which I am to be more specially concerned, there are one or two possible misapprehensions which I may attempt to remove, not only from your student minds, but from the minds of others, who, with no stronger

claims than I have, may not be so reluctant to tender you their advice and mislead you at the very beginning of your career into wrong views, by persuading you that the study of chemistry may be preparatory to medicine, but is hardly entitled to rank as a department of it. All the sciences, physics, chemistry, natural history—I suppose, with some recent thorough-going specialists, even anatomy and physiology—are to be looked on, if included at all, merely as preliminary to medicine strictly so called, or, as the apostles of this doctrine hail it, the healing *Art*, never the healing *Science*. I shall not dispute those terms, if *Art* be preferred, but the preference is significant of a certain attitude of mind, and it indicates that medicine is still regarded, and by certain people is preferred to be regarded, as empirical, rather than as scientific, or as having any foundation in science, or requiring any preliminary training in science.

It is not unlikely that the majority of those among you who have come here for the first time, have not had their attention hitherto taken up by any kind of knowledge but that which is acquired by reading. All knowledge is in books, so you have been hitherto taught; the library is the true modern university; if a man have written a book, there is no need to be taught by him personally;

what are the hundred best books? who are the hundred greatest men? Such are some of the stock cries and conundrums of latter-day ignorance, and the result is that the sources of knowledge which may have been used by some of the writers of the books are overlooked by the student, no less than by the general reader. The student comes to the study of science and of medicine with a strong bias in favour of book-learning, and he is apt in consequence to substitute it for the genuine knowledge which it is the aim of a University curriculum to give him.

Hence at the beginning of your course, you, the first year students, will meet with two novelties, perhaps some may find them stones of stumbling. They are: (1) the employment and constant cultivation of your faculties of observation, and (2) the insufficiency of book-learning in the attempt to acquire an effective knowledge of the phenomena of any branch of physical science.

The methods of learning to which you may have been hitherto accustomed will have to be superseded, or, at all events, very greatly supplemented by new methods. As the subjects which you, by your presence here, have come under a sort of obligation to study are different from those which one learns in a pre-professional stage of existence, so the methods of study are markedly

different. Hitherto you may have taken statements on trust from books ; now you have yourselves to undergo the discipline of observation of the actual phenomena. You will very soon find that no amount of telling, no amount of reading, can be substituted for your own personal cognizance of those phenomena. The labour involved in this mode of learning is so great, the apparent progress is so slow, the field of scientific knowledge to be gone over is so vast, the time at your disposal is so brief, that I can understand and sympathize with the student who, after a steady trial of a few weeks, after the first novelty of the subject is worn off, after discovering that his capacity for this kind of study is less than he supposed, that in short his scientific, and perhaps real education, is just beginning, is conscious of despair of ever succeeding at all.

The other novelty which the student has to face is the character of the subjects themselves. He is taken away from the study of words and literature ancient and modern, of history and biography, of newspapers, fiction, and politics, to learn what has been discovered in the world of nature. It has been impressed on him by critics and philosophers that the proper study of mankind is man, and that there is nothing great in man but mind, and he is inclined, it may be, to look disparagingly on

the universe of matter on which he has now for the first time in his life in sober earnest to meditate. At the beginning of his journey into medical learning, for which he has come unprovided and unprepared, he does not see clearly why his steps should be diverted from the road which seems to go straight to the end he has in view, to enter upon by-paths which lead in apparently different directions. He questions : "Why all these preliminary studies ? Why not begin the study of medicine without all this introductory work, which by and by I shall forget, and subsequently never shall require ? What is medicine to chemistry, or chemistry to medicine, that I, the medical student, should have to weep over the learning of it, and have to be examined on it, and spend time on it ? If I want medicines for myself or any one else, I can get them at the druggist's. I am not going to be an analyst ; chemistry is of no use to me in medicine." Starting with this belief, acquired, it may be, from some medical practitioner, he refuses to take the trouble to learn the subject. Then he calls it difficult and uninteresting, and finally asserts not only that a medical man does not require it, but that it should be done away with. I have heard medical tradesmen advocate this.

If the student or other person who makes this

demand really does not know what essential connection there is between chemistry and medicine, then it is time for him to learn that for centuries there has been a closer bond between them than between medicine and any other branch of science. But if the student or other person know that there has been and is the closest union between them, and yet asks the question as if he had doubt about it, I do not see the connection that exists between his inquiry and a desire for the truth. He must have some additional motive in propounding the doubt.

Let me see if I can indicate the connection between chemistry and medicine.

If we assume, what seems to be the case, that there was a body of ascertained experimental facts, and a theory to unite and interpret them, taught in Egypt in the early centuries of our era, and that this *science*, let it be called so even at that stage for want of a better word, was known by the name of *Chemia*, we find that we are dealing with a subject of great antiquity, of obscure origin, but of traceable descent from then till now. This was a science of matter, and of the changes of matter, just as its modern descendant is, but it was limited in its scope and aims. It dealt probably with the metals only, and with them under one aspect. Speculations as to other changes of matter were

subordinated to the all-absorbing notion that the metals could be changed one into the other; and not only does this seem to have been the view as early as, if not earlier than A.D. 400, but it prevailed from that time without a break till the middle of the seventeenth century. Very few theories—whether they have been right or wrong—can boast of such a prolonged existence as that. But beyond its own sphere as an attempt to account for some changes which the metals undergo, the theory had small influence. By being confined to a few bodies it was doomed to failure, for it propounded an explanation of a phenomenon which did not exist, to wit, transmutation. But in spite of all that it maintained itself for centuries, for ten of them, and why? because if the chemist were successful the result would be endless gold heaps. The pursuit was maintained not because it would be a wonderful thing to know the secret working of nature in the fabrication of the metals and to understand the reason why one metal arises from the same original ingredients rather than another, but because the man who could succeed in turning lead or copper into gold would become a man of power. After all, the alchemists, I fear, were but mechanics, in spite of their thanksgivings for the success they thought they could achieve. It is not necessary for me to take up your time with

their ideas. It is enough to remember that they prevailed for centuries.

There was, however, another direction in which chemistry, though not under that name, developed. There were always men who worked at the practical arts and who became acquainted with some of the properties of matter. These men in the course of effecting their purposes discovered many substances. They tried the effects of heat upon bodies separately and conjointly, they found out new compounds, and accumulated a body of facts of real value to them, which took the form of receipts and trade secrets. These workers discovered colours natural and artificial, dyes, metals and alloys, salts of many kinds, glass, pottery, and a multitude of other things which have been used in everyday life for ages.

Lastly, there was a third factor in the investigation of natural products, which also led to an elaborate preparation of them, and that was the demand of the physician for medicines. He was actively employed in finding in nature materials to assist him in combating disease, and he devised complicated draughts which he administered to his patients, who well deserved the name for submitting to his treatment. Though neither an alchemist nor a technologist, the physician could not avoid using some of their methods. His

concoctions, used for the vaguest reasons, were made mostly by distillation and extraction. His materials were derived almost solely from plants. He avoided metals and minerals, and their compounds.

It was not till the beginning of the sixteenth century that there arose the man who was to alter this and ultimately to concentrate the scattered chemical knowledge of the time. It was Theophrastus von Hohenheim who pointed out that one of the pillars of medicine was alchemy, but that alchemy was not merely the perfecting of the inferior metals, as they were considered, into gold, but that it included also the chemical preparation of all materials for man's use, including medicines for his ailments. He went further too, for he discarded the vast potions then employed, introduced active drugs in small doses, and advocated the employment of mineral and saline medicines. But as the preparation of these were possible only by a study of their properties, the physician became of necessity a chemist. All this, however, was not effected without fierce controversy. Paracelsus from the day he lived down to the present time has been considered the embodiment of a charlatan. The enormous stimulus he gave to medicine in the sixteenth century is ignored. The fact that the doctrines of himself and of his followers ultimately prevailed in spite of all the opposition of the dis-

ciples of Galen is usually kept in the background. But the outcome of the use of what were called chemical or spagyric remedies was the establishment of schools where instruction in the preparation of these remedies, or chemistry as it was called, was given.

As far back as 1572, a well-known French naturalist and alchemist, Jacques Gohory by name, a thorough-going Paracelsian, and editor of some of his works, had a herb garden in the neighbourhood of Paris, where several notable physicians used to assemble to discuss questions of natural history, and to prosecute chemical researches in the laboratory. Out of this garden and these meetings grew ultimately the *Jardin des Plantes*, and the medical and science school which forms part of it, and in which a long line of distinguished chemists has flourished.

There was a chemical laboratory, too, at Sedan, and a pupil, by name John Beguinus, who had been trained there, settled in Paris at the very beginning of the seventeenth century—about 1601—opened a laboratory, where he gave practical instruction as well as lectures, and for the use of his students, “to save him the trouble of dictating his methods, and them the trouble of writing them,” compiled a little manual, the first real chemical text-book that ever was published. It was so

successful that on the average it went through an edition a year for fifty years.

It was not, however, all plain sailing for the chemists. Beguinus, to whom I have just referred, tells us himself that his laboratory was broken into, all his preparations taken away, everything wrecked, and he himself thankful that he escaped with his life. The feelings of physicians ran pretty high some three hundred years ago.

The Paris faculty was very jealous of the instruction given in the botanic garden there, and as for chemistry they wished to have complete control of it, since, "for sufficient cause and consideration, this science was prohibited and censured by Act of Parliament." It has taken no little time for the conception of science so to grow that such action on the part of any Parliament would not now be possible.

The effect of the preparation of chemical medicines, as they were called, was two-fold. (1) It made pharmacy a very well defined subject; (2) it opened up the way for a theory of chemical action, independent altogether of medical, alchemical, or other application, by the accumulation of numerous facts, and by the study of a number of changes and reactions. It was here where the medical or pharmaceutical chemistry and alchemy for the moment coalesced. The time was ripe

for discussion ; opinions about the nature of the elements or principles of compound bodies, held by the alchemists on one hand and by the spagyrista on the other, were subjected to a minute criticism by Boyle, who agreed with neither, and who proposed a definition which has since been adopted as the most reasonable. In another direction Becher gave the first generalized theory of the most important of all chemical actions—oxidation—which, although subsequently proved to be erroneous, prevailed for a whole century, quite as long as our present theory, and helped chemists to the better understanding of many phenomena, and to the discovery of many elements and compounds.

Thus chemistry in the seventeenth century, as a science apart from all applications, started on an independent existence, with the sole aim of finding out the laws and processes according to which one kind of matter acts upon another. But it had no sooner done so than it rewarded pharmacy and technology ten-fold. Immediately the knowledge of all kinds of substances increased, and the pharmacist then, as he is now, was bewildered with the abundance of material with which chemical investigation supplied him.

The services, however, rendered to medicine by chemistry do not stop with an improved phar-

macopœia, with purer drugs, and with the methods of detecting adulterations in them. It has gone much further. It has demonstrated that animal and vegetable life depend on a series of chemical actions of a complicated character, very difficult to follow, just because the substances involved are constantly undergoing change under very peculiar conditions. It is in this department that chemistry is of the greatest importance to the medical student and physician. It is by chemistry alone that the knowledge (such as it is at present) of the constituents of the body has been acquired; it is by chemistry alone that the normal changes which go on in health, and the abnormal changes which occur in disease, can be followed and understood. Physiological and pathological chemistry are essential parts of a physician's training and equipment, if he would really understand the very complex problems which are set before him.

It is therefore not merely a preliminary course of chemistry which will suffice for a medical curriculum. Chemistry is not simply a preparatory study to be got over in six or nine months, and then to be abandoned as no longer of any use in medicine. Chemistry is part and parcel of the most abstruse branches of medical study. It runs through the whole subject from beginning to end. It stands at the entrance, because the student

must know the elements of matter—the elements which make up the material body that he is going to study in health and disease. It faces him in physiology, in therapeutics, in dietetics, in pharmacy. Without it practical medicine would be deprived of one of its helps to diagnosis and treatment. In very many departments of legal medicine chemistry is all-important. Without the substances discovered by modern chemistry, surgery could not have progressed as it has done. Medicine therefore, in so far as it is a science, is based essentially on chemistry; in so far as it is merely an empirical art, it depends on it to perhaps an even greater extent.

You can understand therefore that I do not believe that chemistry can be made into a mere preliminary scientific subject; for the very plain and practical demonstration which I have tried to put before you shows that medicine had to depend upon chemistry before it could be called a science, and is interwoven with it and dependent upon it still more now that chemistry has become a pure science. It is in the nature of the two subjects, and any artificial attempt at excluding chemistry from medicine, as an essential part of it, will result in the same disaster for medicine—not for chemistry—as when the latter was forbidden by Act of Parliament.

Owing to this indissoluble connection which has always existed between chemistry and medicine and to the fact that most of you now present, are students of medicine, I have thought it expedient to put before you the most general aspect of that connection, so that you should approach the study of the science with the view of gaining knowledge both valuable in itself and indispensable for your later progress. I wish you, if possible, to study the subject itself, regardless of examinations. I can assure you that if by judicious, moderate, but well-sustained and steady effort, you do what you can to understand the points that will be brought before you, and familiarize yourselves with them, you will not only pass any examination you may have to undergo, but you will have laid up knowledge really worth having, and have acquired a habit of working which you will find of infinite advantage to you later on. I would go even farther and express a conviction at which I have arrived, for the unpopularity of which amongst many I am fully prepared. I am of opinion that, considering the extent and difficulty of the subject, and its altogether special bearing upon medicine both in theory and practice, the medical student has not enough of time to give it fair attention, and especially to learn that portion of it which bears

more particularly upon his future work. Coming, as most of you do, unprepared not only for remembering the facts, but for following the reasons of classification and explanation, you spend a portion of the first session in mere mental discipline, an excellent and indispensable thing undoubtedly, but purchased at the expense of much learning, which has to be acquired subsequently by mere reading. At the end of the first year the student, by dint of attention and steady work, has learned enough of the general principles, and of the main characters of a score of the commonest elements and a few of their compounds, to enable him to pass a reasonably comprehensive examination within that range. The subject, according to present custom, is then dropped, and the student congratulates himself that he is done with it for all time coming, and may now forget what he has learned. He does so very quickly; because he has not grasped the full significance, the wide, I may say, the universal bearing of what he has acquired. It does not form an integral part of his thinking, and he does not suppose that it can have any kind of bearing on his subsequent professional studies. When he comes to physiology and finds himself confronted by a much more difficult department of the science, if he has any reflection at all he

will see that the amount he has been able to acquire during his first session is insufficient to enable him to follow with ease and confidence the description of the variety of absolutely new substances contained in man and animals, which constitutes zoochemistry. He has not had time to furnish himself with such a knowledge of the general principles of organic chemistry as will help him through the difficulties of physiological chemistry. The nomenclature, the classification, the reactions and decompositions are all different from those which he has found it hard enough to learn in the first year of his course ; and he goes forward not so well prepared as he ought to be.

My conviction, after many years' observation of the working of the system, is that there ought to be a compulsory senior course—I say nothing about the length of it—a senior course in which the student of medicine should be carried forward to that part of the subject which has a special bearing upon his professional work. I may as well say at once that this would not do as a substitute for the present course, for at the root of all chemistry lies a perfect familiarity with the elements and their compounds, and the various reactions they undergo. Not until that has been learned can any good come of a study of organic chemistry.

It may seem very hard to you and to the advanced medical reformers that this should be so, and that a science should usurp such a dictatorship. But if you will look at it dispassionately you will perhaps find that your grievance amounts to this: our bodies are pieces of matter and are placed in a universe of matter, and our bodies, like the rest of the universe, are undergoing constant changes, which are called familiarly *chemical*; if we want to know what they are, we must take the trouble to learn them. It is hard, perhaps, but there is no escape from it. Whatever it may have been once, chemistry now is no longer limited to this or that kind of substance. All matter has chemical properties and is capable of undergoing change, and hence chemistry, along with mathematics and physics, ranks as one of the fundamental or general sciences, the help of which must be invoked in one shape or another by all the others which are either composite like geology, descriptive like biology, or practical like medicine.

The claim, therefore, which I have put forward for chemistry is not an attempt to exalt the subject I have specially to bring before you hereafter, but rests upon the nature of the material universe. Wherever there is matter there is a display or a

potentiaity of chemical action. It may be ignored, it may be forgotten, it may be legislated against. Chemistry may be put out of the medical curriculum by Act of Parliament, but the human body cannot be deprived of its chemistry by Act of Parliament; it will still go on presenting chemical problems for the man who will study them, and whoever solves one of these problems compels all the rest of the world to follow him. A law of nature once discovered makes itself obeyed. Chemistry, therefore, forms not a section of the preliminary scientific study to medicine, but medicine depends for its progress and emancipation from empiricism upon what chemistry is able to tell it.

The universality of the field of chemistry just referred to, which has liberated it as a science from special applications, brings up its claim to be regarded as a factor in general culture of the higher order. Considering, as I have already said, that our lives are spent in the material framework of the body, subject to the laws of the material universe, and that our thinking and acting make their results known through the body, it seems to me to be a fair demand that a man who proposes to be cultured should have at least some knowledge of these laws. If this be granted, then a knowledge of the fundamental constituents, the elements of matter, and the manner in which they combine,

should be a part of the knowledge possessed by every one who leaves the University in the character of a generally informed man. A knowledge of chemistry gives an insight into every material object in nature; the whole universe assumes a new aspect, and he who has a key, be it to some only of its secrets, finds it no longer hostile, but most amenable to treatment. It seems to me that a knowledge of the chemical properties of matter is as requisite for general culture as of heat or light, or of any of the physical properties of matter—in fact, the divorcing of these studies by artificial restrictions is detrimental to both. The student, for the matter of that, the modern graduate, who has no knowledge of what has been doing of late in physical, chemical, and natural science, cannot claim to be fully trained. His knowledge is positively imperfect, and certain mental faculties have never been called into use.

Here, possibly, the question may be seriously argued whether the study of science does afford sufficient mental training, whether it is of a kind that can be substituted for that afforded by other disciplines? This is a topic on which I should not enter without knowing more of the objections to a scientific training; but whatever objections may be raised, I should say that I do not propose substituting one for the other, but I would advo-

cate an employment of both. While philosophy and literature, languages, history, and so on, train the mind in a particular way, they leave untrained the faculty of observation and the power of drawing conclusions from observed facts. To supply this defect, the scientific study of nature is an educational necessity. I have no doubt myself of the mental training which, for example, a thorough study of chemical analysis in a laboratory affords. There the student learns very decisively the certainty of law and order in the material universe. He learns the important lesson that he must give up preconceived opinions in face of facts he has himself elicited. He finds that he cannot escape by any process of reasoning from the errors into which he may have fallen, but that they irresistibly work out their own results. He comes to realize the truth of what has been said, that the only way to command nature is to obey her.

This seems to be a discipline as good in its own way as that afforded by any other subject of study, and, when culture is the aim, not to be ignored or contemned. It is not one time, but many times, that I have seen students who had passed through one kind of training prove that their scientific training was all to be acquired, and who acquitted themselves on trial less satisfactorily than others who had not had their advantages.

Their over-training in one direction had stunted their capacities in another.

The same quality of universality which entitles chemistry to a share in a scheme of general University culture, as distinguished from specialized courses in science, philosophy, letters; or from strictly professional training (though here again I think that chemistry, both from its training and its matter, might be studied with profit both by law and by divinity students, as indeed I have had students from both faculties), makes it an indispensable and important part of every course in science. There is no department of natural science for which a knowledge of chemistry is not a necessity, while obviously the science itself in all its extent may become the main object of attention.

If there be any now present who are aiming at a science degree, it may not be out of place if I should remind those who may have already heard it, and tell those who have not, that the grade of acquirement in the different subjects is on a higher level than that required for the same in other degrees. Taking my own subject as an example, the knowledge of chemistry which might be sufficient to entitle a student to pass for the ordinary degree in medicine, for which his attainments are tested in so many different ways and in so many

subjects, would not be sufficient for a degree in science, say in biology, where, having only a comparatively small number of subjects to study, his acquirements in each ought to be proportionally higher, and to have the stamp of intimate and personal acquaintance with the subject displayed, and by his capacity to understand and discuss debated points. Such knowledge can be attained only by prolonged study. But in my experience students are apt to rush at their degree examinations as things to be got over. These examinations do, I fear, bulk more largely before the students' eyes than the preparation and substantial knowledge which form the evidence that the degree has any meaning and confers any distinction. It seems to me that the significance of a degree as a stamp of knowledge and skill is misunderstood.

The science student makes too much book work of it. He has a knowledge of names and descriptions, but he is not always able to recognize the objects. He sets himself less to learn the subject than to "get up" a certain amount for the examination. To assist him in this he goes through a certain process of mental forcing either at his own hands or those of a professional forcer, a species of fattening up, like that of sheep or oxen for an agricultural show. In the whole process there is not one word of acquiring knowledge,

because it is better than ignorance; not a whisper of training the mental faculties, of observing, of reasoning, of exercising patience, of acquiring promptness and dexterity in solving the problems nature offers, of getting an acquaintance with the marvels and the beauties of the material world wherein we live, so that as the result of the course of study the graduate is better fitted for the life before him. There is not even the lower motive proposed: "Will a knowledge of this science ever come of use to me as an instrument to further any other object I may have in view?" It is mainly this: "People demand degrees; therefore I want a degree, of course with as little trouble as possible, with the smallest possible expenditure of time, money, and labour, and on the minimum of knowledge." It is the last revised version of a well-known passage which runs: "Wisdom is the principal thing, therefore get wisdom, and with all thy getting get understanding." But it reads differently now in the text of the modern student: "Examination is the principal thing, therefore get—*through*, and with all thy getting get thy degree."

To all of you I would remit the careful consideration of the question how to get the greatest amount of knowledge and skill, the greatest amount of training and discipline, the widest and most

liberal views of the aims of the sciences you will have to take up during your residence for the next few years at the University, knowing well that if you find the right answer you will go forth into active life not only provided with the academic stamp, which is so coveted, but with well-stored and well-trained minds, with a love of your profession, and a capacity for work. I hope you may find *the* right answer.

And so I leave in your hands that share in the work of the coming session which *you* must do, each one for himself and in his own way.





